AT THE ENTERPRISES AND INSTITUTES

UDC 666.263.2:621.373.826

LASER-MECHANICAL TECHNOLOGY FOR PRODUCING MINIATURE BUSHING FROM STEATITE GLASS CERAMICS

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Translated from Steklo i Keramika, No. 2, pp. 27 – 28, February, 2005.

A technology has been developed for making bushings from sintered blank washers produced by slip injection molding from steatite glass ceramic K-14. The method is based on the technology for treating watch stones on semiautomatic machines. The effect of laser radiation parameters on the process of piercing openings in blank washers to produce bushings is investigated. Comparative properties or bushings are analyzed.

Steatite glass ceramic K-14 [1] and forsterite ceramic VF52.42-1 are used to produce a dielectric bushing for the case of a semiconductor device. Bushings with an outer diameter of 1.2 mm were produced by slip-cast injection molding with subsequent two-stage firing. In view of the growing requirements imposed on electronic devices, their overall size has to be decreased, bringing the bushing outer diameter to 0.8 – 0.6 mm, The bushing wall thickness in this case may approach 115 μm, which differs little from the size of normal (relatively large) grains used in slip-cast molding.

Laser treatment of miniature products can now become an alternative to traditional slip-cast molding [2]. The authors of [3] obtained leucosapphire bushings for a semiconductor device by diamond abrasive treatment. Actually this technology copies the technology of making stones for watches from ruby monocrystals [4].

We have proposed a technology for making miniature bushings using the technology of stones for watches, but the blanks in our case were washers made of steatite glass ceramic and forsterite ceramic produced by slip molding and firing.

The traditional technology is developed for producing watch stones from corundum monocrystals, when laser drilling of holes in washers causes minimal damage, whereas laser drilling of polycrystalline materials involves the risk of micro- and macrocracking. We have identified sparing regimes for drilling bushes, when no cracking occurs in the opening and its surface becomes glazed. Such blank washers made of polycrystals can later be subjected to diamond abrasive finishing to the required size.

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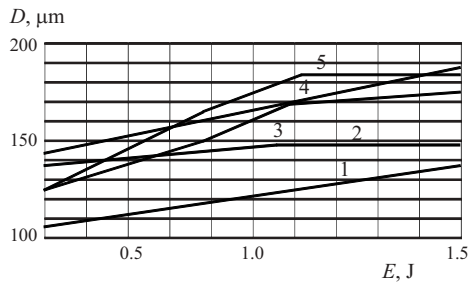

Fig. 1. Variation of outer opening diameter D in a disk from K-14 glass ceramic under laser piercing depending on pulse energy E. Figures at the curves correspond to the number of pulses.

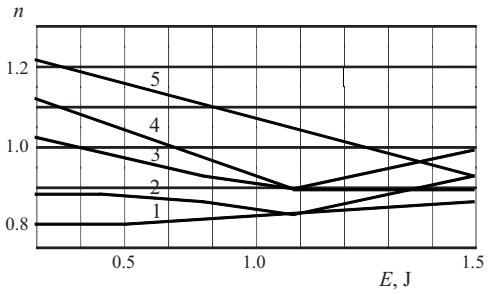

Fig. 2. The effect of pulse energy E and the number of pulses in laser piercing of washers made of steatite glass ceramic on the ratio between the outer and the inner diameters n. Notations same as in Fig. 1.

TABLE 1

Material	Blank size $D \times h$, mm	Bushing size $D \times d \times h$, mm	Electric capacity, pF	Tensile strength, MPa
LF-2	1.2 × 0.7	0.80 × 0.40 × 0.33	0.050	62.6
	1.0 × 0.7	0.60 × 0.32 × 0.32	0.040	66.1
	1.7 × 1.1	1.20 × 0.75 × 0.55	0.071	47.8
K-14	1.2 × 0.7	0.80 × 0.40 × 0.35	0.059	70.2
	1.0 × 0.7	0.60 × 0.32 × 0.32	0.049	81.0
	1.7 × 1.0	1.20 × 0.75 × 0.55	0.073	53.0

We investigated the effect of laser radiation parameters on piercing holes in blank washers for producing bushings. The results of the experiment are shown in Fig. 1, whereas Fig. 2 shows the effect of the same parameters on the ratio between the outer and the inner diameters.

The sizes of blank washers and bushes from magnesian-silicate materials produced by abrasive diamond treatment resembling the technology of watch stone treatment are listed in Table 1. The table also indicates the properties of bushings: the electric capacity of metallized bushings and their tensile strength (estimated in accordance with the diametral compression method in [5]). It follows from the data of Table 1 that according to the Griffith and Weibull theories, the properties of products improve as their sizes decrease.

Semiconductor devices based on bushings made of steatite glass ceramics are shown in Fig. 3.

The proposed laser-mechanical technology for making miniature bushings from steatite glass ceramics can be used in industrial production.

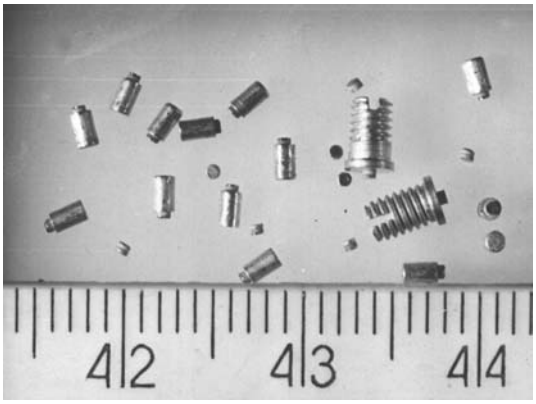

Fig. 3. Semiconductor devices based on bushings made of steatite glass ceramic produced by the technology of treating watch stones.

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